WORK-ENERGY THEOREM

#1

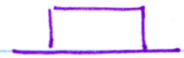
START

$E_g = 0 \text{ J}$

$E_k = \frac{1}{2}mv^2$

$= 312500 \text{ J}$

END



$E_g' = 0 \text{ J}$

$E_k' = 0 \text{ J}$

$$M.E_b + W_{EXT} = M.E_a$$

$$E_g + E_k + W_{EXT} = E_g' + E_k'$$

$$312500 + \vec{F}\Delta\vec{d} = 0$$

$$312500 + (-8000)\Delta\vec{d} = 0$$

$$\Delta\vec{d} = 39.1\text{m}$$

-ve because friction acts opposite to $\Delta\vec{d}$.

#2

START

$E_g = 0$

$E_k = \frac{1}{2}mv^2$

$= 1\,200\,000 \text{ J}$

END

$E_g' = 0$

$E_k' = \frac{1}{2}mv'^2$

$= 75000 \text{ J}$

$$M.E_b + W_{EXT} = M.E_a$$

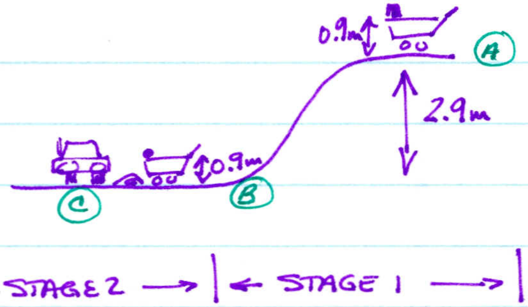
$$E_g + E_k + W_{EXT} = E_g' + E_k'$$

$$1\,200\,000 + \vec{F}\Delta\vec{d} = 75000$$

$$\vec{F}(20) = -1125000$$

$$\vec{F} = -56250 \text{ J}$$

#3



STAGE 1

At (A)

$E_g = mgh$

$= (0.25)(9.8)(2.9+0.9)$

$= 9.31 \text{ J}$

$E_k = 0 \text{ J}$

At (B)

$E_g' = mgh'$

$= (0.25)(9.8)(0.9)$

$= 2.21 \text{ J}$

$E_k' = ?$

$$M.E_b = M.E_a$$
$$E_g + E_k = E_g' + E_k'$$
$$9.31 = 2.21 + E_k'$$
$$E_k' = 7.1 \text{ J}$$

STAGE 2

At (B)

$E_g = 2.21 \text{ J}$

$E_k = 7.1 \text{ J}$

At (C)

$E_g' = 2.21 \text{ J}$ ← E_g does not change while can plows into car (assumption valid if distance travelled while airborne is small)

$E_k' = 0 \text{ J}$

$$M.E_b + W_{EXT} = M.E_a$$
$$9.31 + F\Delta d = 2.21$$
$$9.31 - 500\Delta d = 2.21$$
$$\Delta d = 0.0142 \text{ m}$$
$$= 14.2 \text{ mm}$$

#4

$$M.E_b + W_{EXT} = M.E_a$$

$$E_g + E_k + W_{EXT} = M.E_a$$

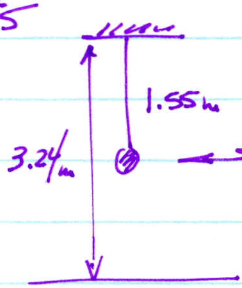
$$0 + \frac{1}{2}mv^2 + W_{EXT} = 0$$

$$\frac{1}{2}(1248)(19.03)^2 + W_{EXT} = 0$$

$$W_{EXT} = -225976\,J$$

ENERGY LOST TO FRICTION (THERMAL)

#5



$$E_g = mgh$$

$$= (1.87)(9.8)(3.24-1.55)$$

$$= 30.97\,J$$

$$E_k = 0\,J$$

$$M.E_b + W_{EXT} = M.E_a$$

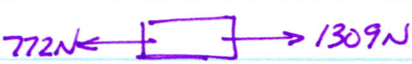
$$E_g + E_k + 0 = E_g' + E_k$$

$$30.97 = E_k'$$

$$30.97 = \frac{1}{2}mv^2$$

$$v = 5.76\,m/s$$

#6



$$M.E_b + W_{EXT} = M.E_a$$

$$E_g + E_k + W_{EXT} = E_g' + E_k'$$

$$0 + \frac{1}{2}mv^2 + W_{EXT} = 0 + \frac{1}{2}mv^{2\prime}$$

$$\frac{1}{2}(1900)(1)^2 + F_a\Delta d + F_f\Delta d = \frac{1}{2}(1900)v^{2\prime}$$

$$950 + 1309(18.6) + (-772)(18.6) = 950v^{2\prime}$$

$$10\,938 = 950v^{2\prime}$$

$$v_2' = 3.39\,m/s$$

#7 a)

FRICTION

$E_g = 0$

$E_k = \frac{1}{2}mv^2$

$= \frac{1}{2}(7.86)(1.92)^2$

$= 14.49\ J$

$E_g' = 0$

$E_k' = ? = \frac{1}{2}mv^2$

$= \frac{1}{2}(7.86)(1)^2$

$= 3.93\ J$

$$M.E_b + W_{EXT} = M.E_a$$

$$E_g + E_k + W_{EXT} = E_g' + E_k'$$

$$14.49 + W_{EXT} = 3.93$$

$$W_{EXT} = -10.56\ J$$

$$-F_f \Delta d = -10.56$$

$$\mu F_N \Delta d = 10.56$$

$$\mu mg \Delta d = 10.56$$

$$10.78 \Delta d = 10.56$$

$$\Delta d = 0.98\ m.$$

b) $M.E_b = 14.49\ J$ from (a)

$M.E_a = 0\ J.$

$$W_{EXT} = -14.49\ J$$

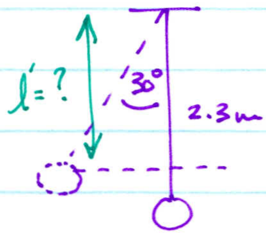
$$-F_f \Delta d = -14.49\ J$$

$$\mu mg \Delta d = 14.49$$

$$\Delta d = 1.34\ m$$

#8

(a)



$l' = 2.3\cos 30°$

$= 1.99m$

Thus child is raised $(2.3 - 1.99)$ or $0.31m$.

$\therefore E_g = mgh = 20(9.8)(0.31)$

$= 60.76\ J$

(b) $M.E_b + W_{EXT} = M.E_a$

$E_g + E_k + 0 = E_g' + E_k'$

$60.76 + 0 + 0 = 0 + \frac{1}{2}mv^{2\prime}$

$v' = 2.46 m/s$

#9 $M.E_b + W_{EXT} = M.E_a$

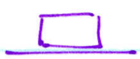
$E_g + E_k + F\Delta d = E_g' + E_k'$

$0 + 0 + 1.37(0.575) = 0 + \frac{1}{2}(0.656)v^{2\prime}$

$v' = 1.55m$

OOPS → JUST NEEDED E_k'. THUS 0.788 J

#10



$E_g = 0\ J$

$E_k = \frac{1}{2}mv^2$

$= \frac{1}{2}m(13.89)^2$

$= 96.47m\ J$

$E_g' = 0\ J$

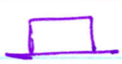
$E_k' = 0\ J$

$M.E_b + W_{EXT} = M.E_a$

$96.47m + F_f\Delta d = 0$

$F_f = -6.43m\ N$

mass still unknow but F_f will be same in new scenario.



$E_g = 0\ J$

$E_k = \frac{1}{2}mv^2$

$= \frac{1}{2}m(41.67)^2 = 868.2m\ J$

$E_g' = 0\ J$

$E_k' = 0\ J$

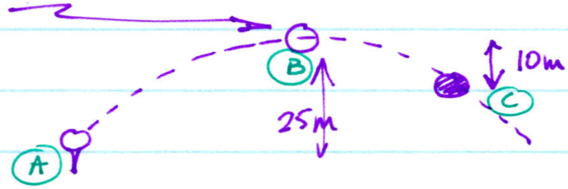
$M.E_b + W_{EXT} = M.E_a$

$868.2m - 6.43m\Delta d = 0$

$\Delta d = 135m$

#11

a)



At (A)

$E_g = 0\,J$

$E_k = \frac{1}{2}mv^2$

$= \frac{1}{2}(0.047)(52)^2$

$= 63.54\,J$

At (B)

$E_g' = mgh$

$= 0.047(9.8)(25)$

$= 11.52\,J$

$E_k' = ?$

$M.E_b + W_{EXT} = M.E_a$

$63.54 + 0 = 11.52 + E_k'$

$E_k' = 52.02\,J$

$\frac{1}{2}mv^{2\prime} = 52.02\,J$

$v' = 47.0\,m/s$

(b) At (A)

$E_g = 0\,J$

$E_k = 63.54\,J.$

At (C)

$E_g' = mg(15)$

$= 6.91\,J$

$E_k' = ?$

$M.E_b + W_{EXT} = M.E_a$

$63.54 + 0 = 6.91 + E_k$

$E_k' = 56.63\,J$

$\frac{1}{2}mv^{2\prime} = 56.63$

$v' = 49.1\,m/s$

#12

$E_g = 0\,J$

$E_k = 0\,J$

$M.E = E_k' = 4.7\times10^7\,J$

(a) $M.E_b + W_{EXT} = M.E_a$

$0 + W_{EXT} = 4.7\times10^7\,J$

$W_{EXT} = 4.7\times10^7\,J$

(b) $W_{EXT} = F_T\Delta d + F_C\Delta d$

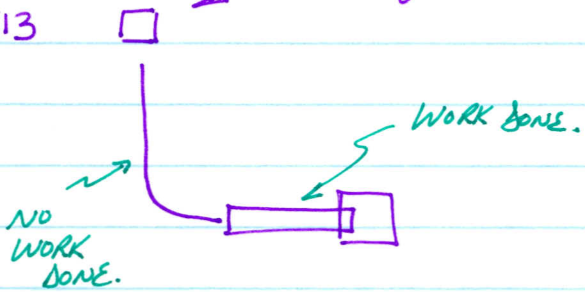
$4.7\times10^7 = 180000(87) + F_C(87)$

$31340000 = 87F_C$

$F_C = 3.6\times10^5\,N$

$M.E = E_g + E_k = 0.00735\ J$

#13



$\therefore$ M.E @ TOP = M.E @ Bottom.

$M.E$ @ TOP $= 7.35 \times 10^{-3}\ J$

$\therefore$ M.E @ Bottom $= 7.35 \times 10^{-3}\ J$

WHILE MOVING ALONG SHEATH

$$M.E_b + W_{EXT} = M.E_a$$

$$7.35 \times 10^{-3} + W_{EXT} = 0\ J$$ ← assumption: bead comes to rest.

$$W_{EXT} = -7.35 \times 10^{-3}$$

$$F \Delta d = -7.35 \times 10^{-3}$$

$$F(0.10) = -7.35 \times 10^{-3}$$

assumption: bead comes to rest at end of sheath.

$$\therefore F = -0.0735\ N$$